

**ANALYSIS OF PYRAMIDAL HORN ANTENNA WITH TRAPEZOID WAVEGUIDE
IN MULTIPLE-BAND: PART 2 - APPLICATION DESIGN**

Taesik Choi * , Sukyoub Kang, Hyodal Park
 Department of Electronics, School of Engineering, Inha University
 253, Younghyun-dong, Namgu, Incheon, 402-751, Korea
 E-mail: spmari@naver.com

1. Introduction

We proposed design of pyramidal horn antenna in application of Radar detector unit (RDU) for multiple-band. Similar to rectangular waveguide filter using inductive post, we also employed horn with adding post to select specified resonant frequency in each band. Using waveguide what we proposed in part I , we optimized work to achieve our design specification.

2. Overview of RDU

In traffic system, the handheld radar guns have evolved ever since to increase range, improve targeting and outwit radar detectors. Radar detector unit (RDU) as a countermeasure of speed gun informs for driver where to operate speed gun policeman has and a safety warning such as emergency vehicle, road hazard, railroad warnings in these day [1]. Because of this, there is growing high expectation for preventing from accident in advance. Currently, having a RDU is allowed for driver in U.S only except some states. But, demand on RDU is increasing in the near future [2]. When the radar operator may spray moving cars with microwaves, the emitted signals from it transfer RF circuit parts and modulate it through the horn antenna and cause the unit to alarm and display on. Figure.1 shows block diagram of radar detector.

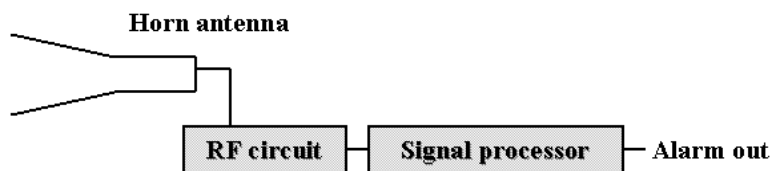


Fig.1: Block diagram of Radar Detector Unit

Radar's microwaves, which reflect off objects to indicate speed, have climbed in frequency from the original X band (10.525 GHz) to K band (24.150GHz) in 1970s to Ka band (33.4 to 36.0 GHz) in the late 1980s [2]. RDU should be detected in given frequencies specification and designed not to interfere with adjacent band during operation [3].

3. Design Procedure

In RDU, there are some the important design factor to be considered. When connection between horn antenna and circuit box containing RF system, we should modify properly because circuit box behave as wide cavity. That is, circuit box including trapezoid waveguide is real waveguide of horn antenna. Also, single-ridge structure height is approx. its waveguide, since antenna feed connects microstrip line from mixer. Similar to addition post inside waveguide, we also apply it on the horn roof. Fig. 2 shows RDU configuration. Especially, fig.2 (b) shows waveguide part in detail.

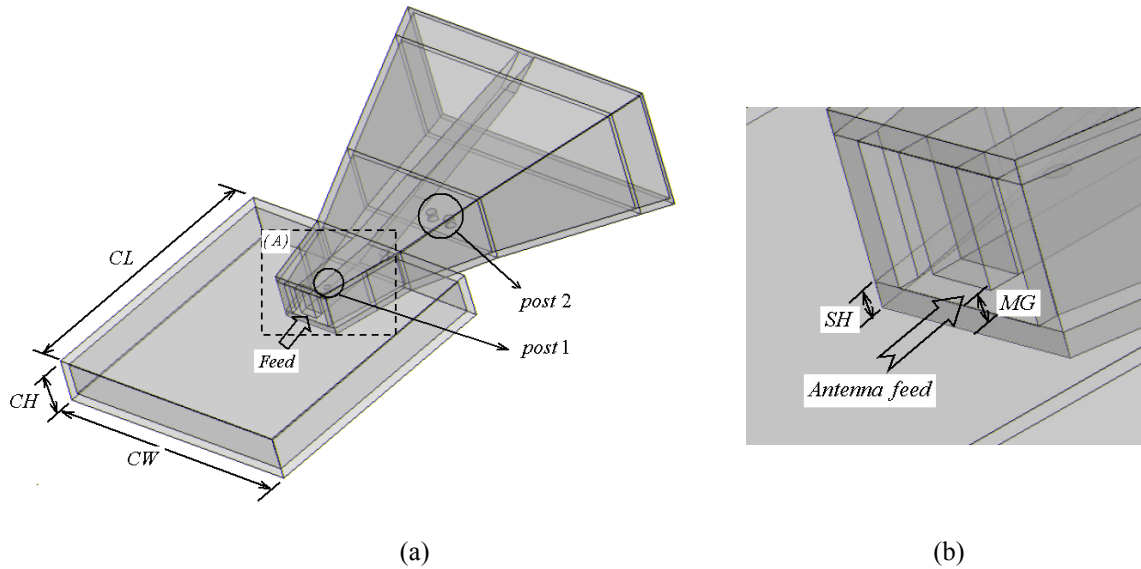


Fig.2: (a) Configuration of Radar Detector Unit (b) Waveguide part in detail

Circuit box size is 36.03mm length(CL), 36.4mm width(CW) and 6.14mm height(CH). Post 2 attached horn's roof is placed 10 mm apart in front of horn's throat. As shown in Fig.2 (b), thickness of horn antenna(SH) is corresponding to its Teflon substrate of circuits and height of gap (MG) is equivalent to microstrip feed-line from mixer. To modify horn antenna properly, we set the optimization variables such as post height, position along z-axis, gap between posts along x-axis by following simple design rule. Optimal work was processing in order as we demonstrated.

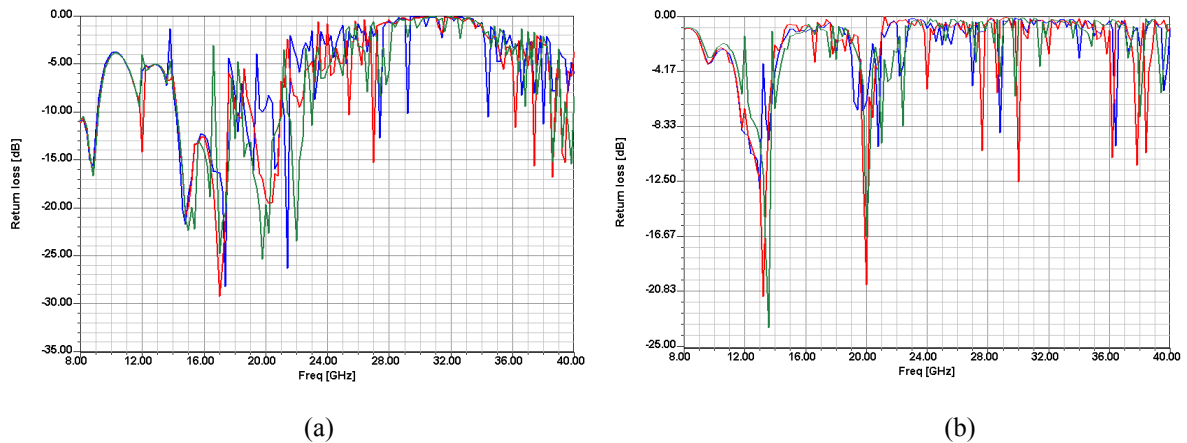


Fig.3: (a) Result of return loss varying post height

(b) Results of return loss varying post position

First, the optimal height of post 2 with 0.2mm interval is found to be about 1mm to 1.4mm in front of second bending point. Results of return loss against frequency for post height are presented in Fig.2 (a). Resonance frequency is shown at Ku-band what we unwanted. To reject this band, we experimented second optimized work as varying position of post 2 along z-axis. Fig.3 (b) shows that result. Contrary to fig.3 (a), fig.3 resonance frequency of (b) was clear partly in adjacent band, but not in X-band.

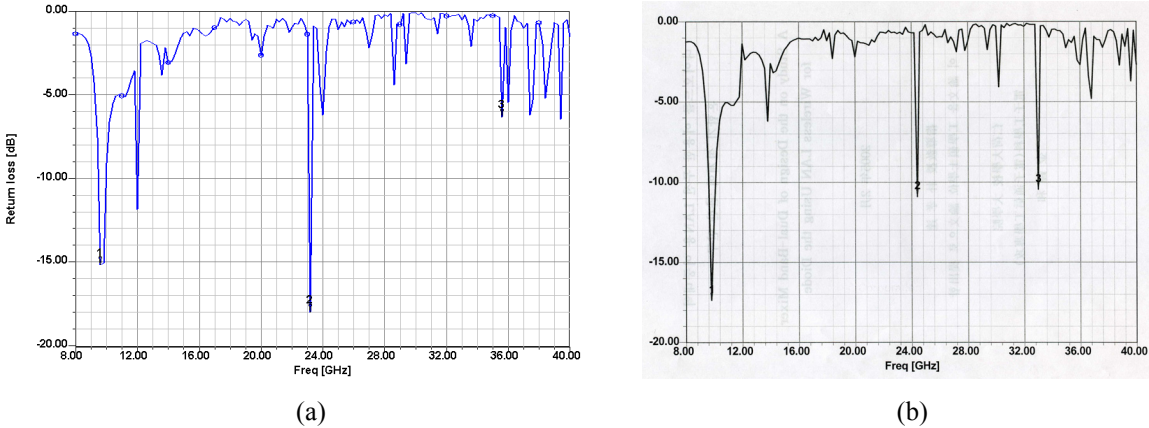


Fig.4: (a) Result of return gap between post2s (b) Results of return loss varying post position along z-axis backward

When we add post 2 in symmetrical and varied gap between post2s (G_p) position along x-axis, we obtained optimal value. In fig.4 (a), it is clearly that owing to proper selection, $G_p = 1.8mm$, re-shifted optimal value at X-band. But, it did not resonance point in Ka-band. Based on fig.4 (a), we experimented post2 shifted along z-axis backward. As a result, we obtained optimal value to satisfy in given specification fig.5 (b). Table.1 shows summary of results during optimization work.

Optimal Work No.	Variables	Optimal value	Results
#1	Post2 height (1mm ~ 1.5 mm)	1.4 mm	-16.68 dB @ 8.60 GHz -23.42 dB @ 22.4 GHz -5 dB below @ Ka-band
#2	Post2 position along z-axis toward aperture (21.0mm~20.0mm)	21.6 mm	-20.9 dB @ 13.20 GHz -20.8 dB @ 20.00 GHz -5 dB below @ Ka-band
#3	Gap between post2 along x-axis toward side wall (0mm ~ 1mm)	1.8 mm	-15.11 dB @ 9.60GHz -17.93 dB @ 23.20GHz -6.29 @ 35.60 GHz
#4	Post2 position along z-axis backward aperture	Opt:s =0.4mm	-17.35 @ 9.80GHz -10.89 @ 24.40GHz -10.45 @ 33.00 GHz

Table.1: Summary of result during optimization work

Fig.5 shows fabricated real horn antenna model. Total antenna length including circuit box is 83mm and its width is 39.5mm.

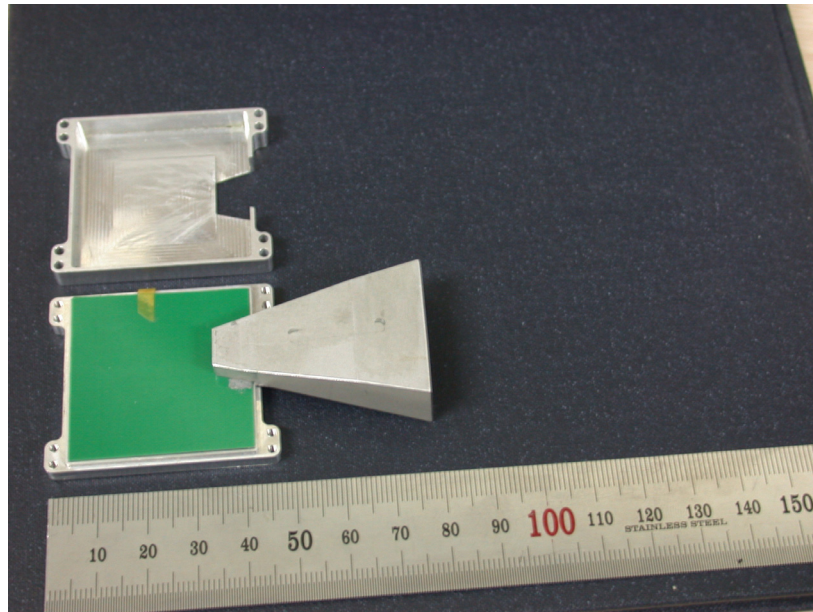


Fig.5: Fabrication of horn antenna for Radar Detector Unit

4. Conclusion

In this paper, we experimented the small-size horn antenna with trapezoid type waveguide in application of Radar detector. For operating X-and Ka-band, we set optimal variables and taken proper optimization work to fit real model including circuits box. As a result, we obtained as varying post2 height and position, respectively. Through this process, horn antenna we proposed and designed will to use radar detector unit properly.

4. Reference

- [1] www.auto-radar-detector.com
- [2] Mark Fischetti "Working knowledge- Gotcha", Scientific American, Mar, 2001
- [3] Glen D. Martison, Mark M. Burin "Radar detector technology" Applied Microwave, summer 1990 pp.68~85